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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : A61B 17/60, F16B 2/12	A1	(11) International Publication Number: WO 88/01152 (43) International Publication Date: 25 February 1988 (25.02.88)
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(21) International Application Number: PCT/GB87/00584

(22) International Filing Date: 19 August 1987 (19.08.87)

(31) Priority Application Number: 8620504

(32) Priority Date: 22 August 1986 (22.08.86)

(33) Priority Country: GB

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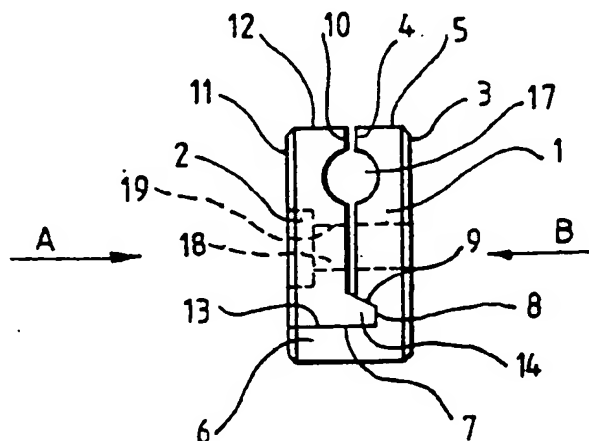
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(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK, FR (European patent), GB, GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), SU, US.

Published
With international search report.

(54) Title: A CLAMPING DEVICE



(57) Abstract

A clamp for the pins and rods of a bone fixator made of a lightweight plastics material and comprising a pair of clamping discs (1, 2) mounted on a common axis. The pins and rods are held in a passageway (17) or passageways formed between the confronting faces (4, 10) of the discs. To resist separation and relative rotation of the discs (1, 2) as the discs (1, 2) are pulled together by an axially mounted clamping bolt, the confronting faces (4, 10) are provided with specially designed interengageable formations comprising a recess (8) across one face and a complementary projection (14) across the other face.

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A Clamping Device

FIELD OF THE INVENTION

The present invention relates to an external fixator for orthopaedic use and in particular to the clamps for the guide rods and drilling pins of such fixators.

BACKGROUND OF THE INVENTION

External bone fixators have been in use for many years, although recently there has been a marked revival of interest in their deployment in grievous accident situations particularly those occurring in warfare.

Weaponry used in modern warfare is capable of inflicting far more devastating wounds to exposed human limbs than those experienced in earlier times. For example, bullets used in today's army, are designed to a far higher standard of aerodynamics, thus having a correspondingly greater propelling speed during passage to the target area.

The resultant high kinetic energy therefore of the modern moving bullet is such that on target impact, where the target is the human body, the transference of this energy to surrounding tissue results in widespread tissue damage, remote from the actual path of travel of the bullet through the body. Thus although the bullet itself may not strike bone directly during penetration, nevertheless, bone structure in the vicinity of the direct impact area may still suffer shatter and breakage.

A part of this effect is due to the phenomenon known as cavitation where the transference of energy creates

a negative pressure within the tissue, creating enormous soft tissue damage, and sucking in pieces of debris which further complicate the injuries.

Severe bodily damage will also occur from other
5 sources such as exploding shells and anti-personnel devices which also cause bone fractures with attendant heavy soft tissue damage.

The front line surgeon will therefore be confronted frequently with compound fractures incurring loss of
10 bone stock and massive soft tissue damage in the fracture area. In many cases, his patient will have taken some time to reach him and infection will have set in. In addition to this the conditions in which the surgeon will be working will be poor with inferior lighting and
15 general medical facilities. He will normally be working single handedly and not a specialist in the medical problems involved.

There do exist primitive fixators which are used to some effect in these adverse conditions. However
20 they have to employ a bone cement to set the fixator pins which under low temperature conditions is slow to set thus placing a limit on versatility. Additionally once the cement is set later adjustment becomes impossible without intermittent breakage.

25 More sophisticated fixators are also available but for military purposes and in situations where there is a shortage of specialist skills and facilities, their

usefulness is much reduced due to complexity of operation and limitations of use. They also tend to be expensive and too heavy.

For example, a heavy stainless steel known fixator element employs a pair of U-shaped clamps, in the form of scaffolding clamps, one clamp being to hold the guide rod of the fixator, the other the fixing pin.

Each clamp is attached to a disc, the discs having serrated mating surfaces which permit relative rotation through 360°. The clamps are tightened by means of a bolt passing through the limbs of the clamps and centrally of the discs in assembly.

Another known fixator uses stainless steel fixing elements comprised of at least two centrally tapped circular clamping discs having channels across one face of each disc.

A spacer disc is inserted between confronting faces of the discs in assembly, and clamping of the rod and pins is achieved by a nut and bolt passing axially of the discs through the central tappings.

In respect of the former known fixator elements, it is only possible to clamp a single guide rod and fixing pin in the one fixing element, which is a distinct limitation.

Moreover its construction demands the use of a heavy and robust material to withstand the clamping forces necessary adequately to grip the object being clamped without the danger of catastrophic failure.

In the latter case, while being a heavy object, assembly by use of spacer discs between the mating discs is unnecessarily messy. Additionally if a lighter weight material were to be used, for example, plastics, the
5 grip on the objects being clamped would be less than desired due to the tendency of the material to yield outwardly around the objects being clamped, as the clamping force is applied axially of the clamping discs.

Furthermore, relative rotation of the discs is merely
10 dependent on the clamping force exerted, so this tendency is ever prevalent especially where more than two discs are assembled together. This feature of itself, leads to disadvantage even with the known fixator, since whatever the clamping force applied, the later possibilities of
15 relative rotational movement between the discs can never be ruled out.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a fixator which is particularly useful for
20 military purposes in all types of environments where conditions rule out the use of modern sophisticated and expensive fixators, and which does not suffer from their disadvantage and those of the basic bone cement fixators.

This object is achieved by employing specially designed
25 light weight adjustable clamps for the guide rods and drilling pins of the fixator, in contrast to the heavy stainless steel fittings of prior devices.

Th employment of a light weight more flexible material such as plastics, demands a different type of construction than known heavier metallic fixing elements.

According to the invention there is provided a clamping
5 device for the guide rods and drilling pins of an external bone fixator comprising at least two pairs of axially mounted clamping elements, at least one passageway formed between mutually confronting faces of said elements for receiving a said guide rod or pin, fastening means for
10 fastening the elements together to secure the rod or pin in the passageway, and mutually engageable complementary formations between the confronting faces which interact to prevent relative rotation of said elements when in engagement across said confronting faces, and to resist
15 separation thereof as the elements are fastened together around said rod or pin in the passageway.

Normally a number (usually two) or pairs of the above defined interengageable clamping elements are mounted on a common axis and have radial serrations on their
20 abutting faces which permit fixed engagement of the clamped disc pairs at any rotational position through 360°.

The above design may be made in a light weight material such as plastics while still meeting the needs of constructional reliability, versatility and adaptability demanded
25 by modern fixators particularly in wartime situations.

Particular advantages over the prior art lay in its attributes of being light in weight, rotational stabi-

lity, and ability to cope with a random insertion of drilling pins, when arranged in tandem through such intact skin tissues as may be available.

In short, it has all the advantages of the prior art without its shortcomings.

Other advantages of the present invention will become apparent from the following description of a preferred embodiment given with reference to a number of drawings accompanying this specification.

10 BRIEF DESCRIPTION OF THE DRAWINGS

The drawings accompanying the specification are as follows:

Figure 1 is a side view of a clamping device of a bone fixator;

15 Figure 2 is a sectional view through the clamping device of Figure 1, and including a clamping bolt inserted through the central tapping and of a second similar clamping device mounted in tandem;

Figure 3 is an end view of the clamping device of Figure 1 looking along the arrow A;

Figure 4 is an end view of the clamping device of Figure 1 looking along the arrow B; and

Figure 5 and 6 are front views respectively of the confronting faces of the clamping device of Figure 1.

25 BEST MODES OF CARRYING OUT THE INVENTION

The clamping device shown in the drawings is composed of two clamping members 1 and 2.

The clamping member 1 is a flat circular plate made of a stiff plastics material as by injection moulding and defining two parallel flat circular faces 3 and 4 separated by a peripheral region 5.

5 An arcuate projection 6 extends out of the plane of the face 4 along its periphery. The projection 6 terminates at each end in flat surfaces 7 which lie in a plane perpendicular to the circular face 4.

10 The flat surfaces extend into the face 4 to the base wall or a recess 8, the upper wall 9 of which extends across the face 4.

The upper wall 9 is inwardly sloping and divergent with respect to the central axis of the circular plate 1.

15 The other clamping member 2 is formed of a flat circular plate made of a stiff plastics material and defining two parallel flat circular faces 10 and 11 separated by a peripheral region 12.

20 The plate 2 has the same diameter as plate 1 and shares a common axis in the engaged position shown in Figure 1.

The plate 2 has a sectorised portion removed to form a flat face 13 perpendicular to the parallel faces 10 and 11, which rests across the flat surfaces 7.

25 A ledge 14 projects from the face 10 along the periphery of the flat face 13 to engage the recess 8.

The upper surface 15 of the ledge 14 slopes upwardly

to the face 10 and convergent with respect to the common axis of the assembled clamping plates 1 and 2. so as to provide a complementary fit with the wall 9 of the recess 8.

5 The confronting faces 4 and 10 of the plates 1 and 2 each have a channel 16, which in the assembled position shown, mate to form a passageway 17 for reception of a guide rod or drilling pin of the fixator.

10 The plates 1 and 2 each have a centrally tapping 18 forming an axial passageway 19 for passage of a clamping bolt C shown in Figure 2.

The face 11 of the plate 2 has a square recess 20 on the axis of the passage 19 for receiving a corresponding squared head form on the shank of the clamping bolt.

15 The face 3 of the plate 1 has radial serrations S as shown in Figure 4.

As illustrated in Figure 2, a pair of clamping devices of the design shown in Figure 1, may be mounted on the clamping bolt C with their serrated faces in confrontation.

20 With the passageway 17 in each clamping device designed to receive a guide rod and a drilling pin respectively of a fixator, the juxtaposition of the rod and pin through 360° of rotation is then permissible by rotation of one fixing element with respect to the other on the serrations S.

25

The clamping bolt C is then tightened to draw the clamping elements together, from the slightly separated

position shown in Figure 2, until the serrations engage at the desired relative rotational positions of the elements.

As will be evident in Figure 2, the engagement of the ledge 14 in the recess 8 and the surface 13 across the surfaces 7, ensures rotational stability of the discs 1 and 2 in each disc pair and before the rod and pin have been inserted and clamped, and the interaction of these surfaces, including surfaces 9 and 15, constitutes a bearing resisting the forces of disc separation during clamping of the rods and pins.

A variant of the invention is shown in Figure 7. This is designed to facilitate the mounting of two pins or rods between the clamping members 19 and 20. In this case the confronting faces 21 and 22 each have two channels 23 and 24 to either side of a diametrical line of each said face.

A pair of mutually engageable complementary formations are formed between confronting faces 21 and 22, each similar to that formed between the confronting faces 4 and 10 of the Figures 1 to 6 embodiment, namely features 6, 7, 8, 9, 13, 14 and 15 depicted in those figures and herein fully described with reference thereto.

CLAIMS

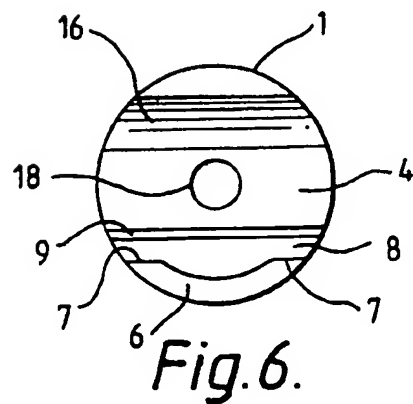
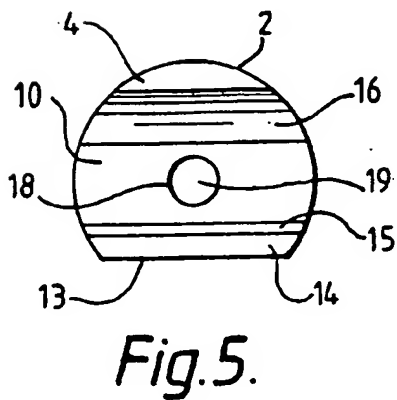
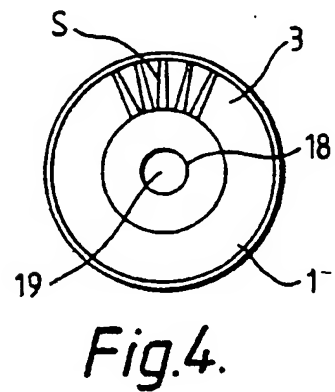
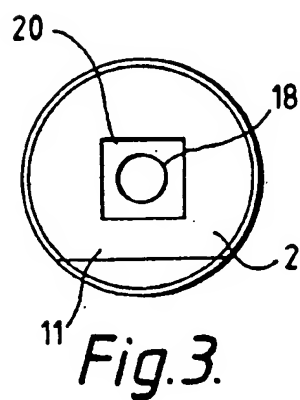
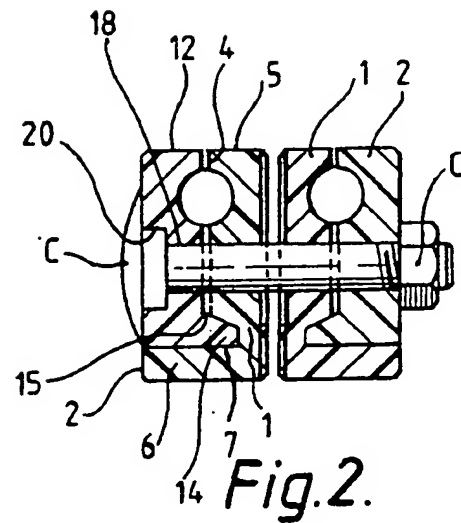
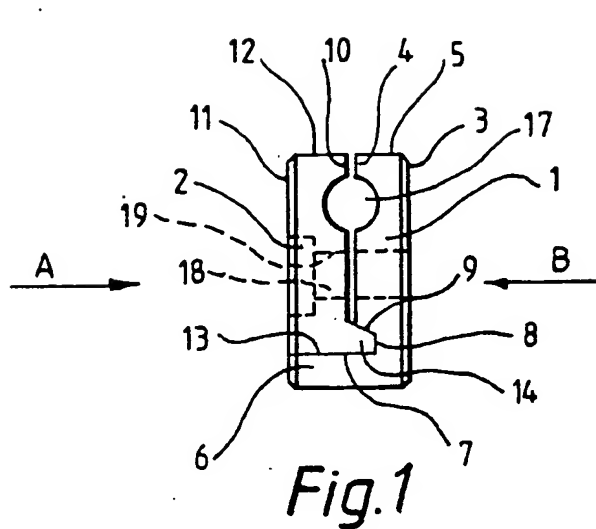
1. A clamping device for the guide rods and drilling
pins of an external bone fixator comprising at least
two pairs of axially mounted clamping elements, at
least one passageway formed between mutually confronting
faces of said elements to form a passageway for receiving
a said guide rod or pin, fastening means for fastening
said elements together thereby to secure the rod
or pin in the passageway, and mutually engageable
complementary formations between the confronting
faces which interact to prevent relative rotation
of said elements when in engagement across said confronting
faces to resist separation thereof as the elements
are fastened together around the rod or pin in the
passageway.
2. A clamping device as claimed in claim 1 wherein said
formations comprise a projection across one confronting
face engaging a complementary recess across the other
confronting face.
3. A clamping device as claimed in claim 2 wherein said
projection has flat upper and lower convergent surfaces
for engaging corresponding flat upper and lower convergent
surfaces of said recess.
4. A clamping device as claimed in claim 3 wherein the
flat lower engaging surfaces of said projection and
said recess are perpendicular to the plane of each
said respective confronting face of said clamping

elements.

5. A clamping device as claimed in any preceding claim wherein said passageway lies on one side of the axis of said clamping elements in assembly, and said formations
5 on the other.
6. A clamping device as claimed in claim 5 wherein the longitudinal axes of said recess and said passageway are parallel to one another.
7. A clamping device as claimed in claim 6 wherein the
10 clamping element provided with said recess is circular, one end face of which is provided with radial serrations for engagement with corresponding serrations on a said circular end face of the clamping element of another said clamping device held in axial tandem,
15 the other end face being formed with a peripheral projection providing said flat lower engaging surface of said recess.
8. A clamping device as claimed in claim 7 wherein the outward extension of said peripheral extension is
20 such that the forward end face thereof is in alignment with the end face of the said clamping element provided with said first mentioned projection on its other end face, whereby both said clamping elements form a mutually co-extensive peripheral surface in assembly.
- 25 9. A clamping device as claimed in any preceding claim

provided with a said passageway and said complementary interengaging formations to either side of the axis of said clamping elements in assembly.

10. A clamping device as claimed in claim 9 wherein each
5 said passageway is nearer to said axis than said complementary interengaging formations.
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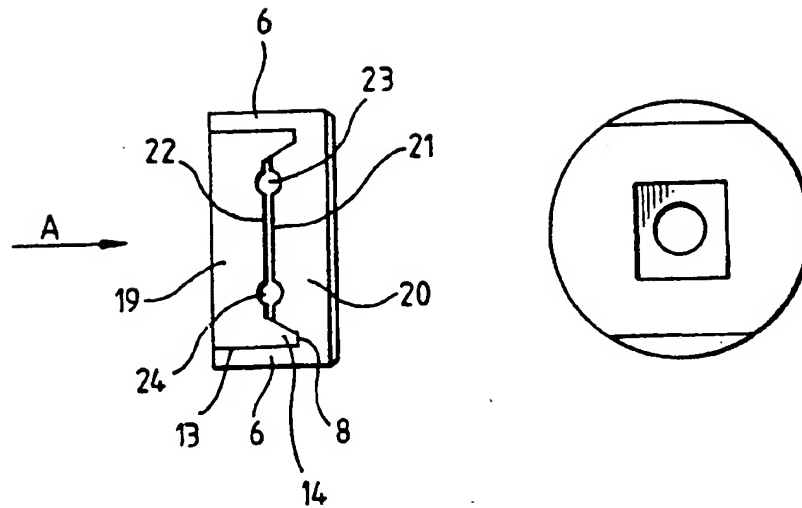
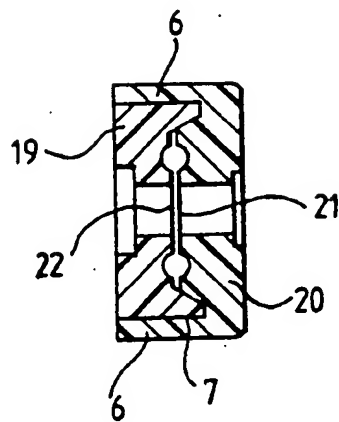


Fig.7.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 87/00584

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC IPC ⁴ : A 61 B 17/60; F 16 B 2/12																							
II. FIELDS SEARCHED <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched⁷</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 30%; text-align: left; border-bottom: 1px solid black;">Classification System</th> <th style="width: 70%; text-align: left; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">IPC⁴</td> <td style="padding: 5px;">A 61 B 17/00 F 16 B 2/00</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *</div>			Classification System	Classification Symbols	IPC ⁴	A 61 B 17/00 F 16 B 2/00																	
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IPC ⁴	A 61 B 17/00 F 16 B 2/00																						
III. DOCUMENTS CONSIDERED TO BE RELEVANT* <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; text-align: left; border-bottom: 1px solid black;">Category *</th> <th style="width: 70%; text-align: left; border-bottom: 1px solid black;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 20%; text-align: left; border-bottom: 1px solid black;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">Y</td> <td style="padding: 5px;">CH, A, 579438 (JAQUET) 9 September 1976 see column 1, line 64 - column 2, line 40; claim and sub-claims 1,4; figures 2,3,5 --</td> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">1</td> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">Y,P</td> <td style="padding: 5px;">US, A, 4620533 (MEARS) 4 November 1986 see column 7, line 40 - column 8, line 17; claims 11,12; figures 15,10 --</td> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">1</td> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">A</td> <td style="padding: 5px;">--</td> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">9</td> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">A</td> <td style="padding: 5px;">FR, A, 2517535 (ZBIKOWSKI) 10 June 1983 see page 11, line 16 - page 12, line 16; claim 6; figures 9A,9D,10 --</td> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">1</td> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">A</td> <td style="padding: 5px;">FR, A, 2557933 (SREBOT) 12 July 1985 see claims 1-5; figures 1-3 --</td> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">7</td> </tr> <tr> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">A</td> <td style="padding: 5px;">US,A, 3096110 (CANTOR) 2 July 1963 see claims 4-8; figures 1,2 -----</td> <td style="vertical-align: top; border-right: 1px solid black; padding: 5px;">2-4</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	Y	CH, A, 579438 (JAQUET) 9 September 1976 see column 1, line 64 - column 2, line 40; claim and sub-claims 1,4; figures 2,3,5 --	1	Y,P	US, A, 4620533 (MEARS) 4 November 1986 see column 7, line 40 - column 8, line 17; claims 11,12; figures 15,10 --	1	A	--	9	A	FR, A, 2517535 (ZBIKOWSKI) 10 June 1983 see page 11, line 16 - page 12, line 16; claim 6; figures 9A,9D,10 --	1	A	FR, A, 2557933 (SREBOT) 12 July 1985 see claims 1-5; figures 1-3 --	7	A	US,A, 3096110 (CANTOR) 2 July 1963 see claims 4-8; figures 1,2 -----	2-4
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Y	CH, A, 579438 (JAQUET) 9 September 1976 see column 1, line 64 - column 2, line 40; claim and sub-claims 1,4; figures 2,3,5 --	1																					
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"Z" document member of the same patent family</p> </div> </div>																							
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search 28th October 1987 </td> <td style="width: 50%; padding: 5px;"> Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold;">1 DEC 1987</div> </td> </tr> <tr> <td style="width: 50%; border-right: 1px solid black; padding: 5px;"> International Searching Authority EUROPEAN PATENT OFFICE </td> <td style="width: 50%; padding: 5px;"> Signature of Authorized Officer M. VAN MOL </td> </tr> </table>			Date of the Actual Completion of the International Search 28th October 1987	Date of Mailing of this International Search Report <div style="text-align: center; font-weight: bold;">1 DEC 1987</div>	International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer M. VAN MOL																	
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 87/00584 (SA 18331)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 06/11/87

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CH-A- 579438	15/09/76	None	
US-A- 4620533	04/11/86	EP-A- 0216563 AU-A- 6269886 JP-A- 62066850	01/04/87 19/03/87 26/03/87
FR-A- 2517535	10/06/83	US-A- 4541422 US-A- 4612921	17/09/85 23/09/86
FR-A- 2557933	12/07/85	FR-A- 2579688	03/10/86
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